CHARTING THE SEAS

IN

PEACE AND WAR

The Story of the
Hydrographic Department of the Admiralty
over a hundred and fifty years
12th August, 1795
to
12th August, 1945

LONDON: HIS MAJESTY'S STATIONERY OFFICE
1947
NINEPENCE NET

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FOREWORD

BY VICE-ADMIRAL SIR RHODERICK MCGRIGOR, K.C.B., D.S.O.

THIS little book is being published to commemorate the 150th Anniversary of the foundation of the Hydrographic Department. It tells you something of the work of the Surveying Service of the Royal Navy and their Civilian colleagues in charting the seas and making them safe for all who sail them, and of the important part this Service played in the War.

It is, therefore, a great pleasure to me to write this foreword and to pay my tribute to the devoted and invaluable work of these officers and men.

R. McGRIGOR
Vice-Chief of Naval Staff

INTRODUCTION

An island nation such as Britain depends for survival, no less in peace than in war, upon the safety of navigation.

Very little is known of the organisation which ensures a large measure of this safety, so the hundred and fiftieth anniversary of the foundation of the Hydrographic Department of the Admiralty seemed a fitting occasion on which to publish some account of this Service to the Nation: but stress of events has delayed the appearance of this little booklet for nearly two years.

Since British marine surveying first began seriously about two centuries ago, there has been a continuity of devotion, endurance and inventiveness in the interests of seamen of which the full story should some day be told; meanwhile this brief sketch may help to give a glimpse of the work of the Surveying Service of the Royal Navy and the Hydrographic Department of the Admiralty.

The World has now been charted and it may be thought that no need exists for further effort except in waters subject to change; but the old surveyors covered an immense amount of ground in a comparatively short time and, though they did it as thoroughly as their means allowed, modern methods such as echo-sounding and other devices designed to detect underwater obstructions reveal that their charts, which were adequate in the days of sail and low-powered steamships, can no longer be considered satisfactory for the fast deep-draught vessels of to-day. It is, therefore, true to say that the greater part of the coastal waters of the World are over-due for re-survey to bring our Charts up to the standard now required.

An immense field of work lies ahead, but co-operation between Maritime Nations provides for the exchange of information for the correction of Charts and it is to be hoped that the necessary surveys will be undertaken.

Reference is made in this booklet to the services of the Hydrographic Department in War; it is, therefore, of interest to know that from the outbreak to the cease-fire in World War II 30,727,000 Charts and diagrams were issued to the Fighting Services and Merchant Navy as compared with 3,500,000 over a like period in peace.

A. G. N. WYATT

Rear Admiral and Hydrographer

2 *June*, 1947

CHARTING THE SEAS IN PEACE AND WAR

WHY CHARTS ARE NEEDED

WHEN you see a vessel changing its course over a smooth sheet of water, you may perhaps guess that she is finding a safe channel amongst shoals and dangers, but do you ever think of the chart by which the navigator is steering? Thanks to his chart the seaman is not deceived by the uniform surface: he sees it as a cover to a detailed picture of varying depths with banks and rocks hidden from sight. On the land he can see beacons and prominent marks that are accurately placed on his chart and by these he can steer his ship into deep water. How is a chart made and how can the navigator be confident that it will give him up-to-date information? The answer is the story of the Hydrographic Department of the Admiralty in a hundred and fifty years of peace and war.

SURVEYING IS BORN

Before there can be a chart there must be a marine survey and although the survey is by no means the end of the business it is a very necessary beginning: so we have to take this story back about two hundred years to see how it all started. Marine surveying in England is a comparatively young science: charts had been published in this country in the seventeenth century but they were all taken from Dutch work. The first home product was Captain Greenvile Collins' *Great Britain's Coasting Pilot*, published in 1695, and its charts look rather crude by our standards: still, they were charts and in their day served their purpose. The trouble with these private jobs was that reprints of the same old plates continued to be issued for half a century, long after they had ceased to represent the facts. We must date serious surveying from about 1750, when the North American war was brewing. Captain James Cook greatly advanced the accuracy of this work by his care in observing bearings and fixing positions in the St. Lawrence River. About the same time George Gauld was making some fine surveys in Florida.

CHARTS AND THE NAVY

When we find that this period saw a considerable outburst of marine surveys in home waters as well as in the theatre of operations, it brings to mind that the mid-eighteenth century saw the emergence of the Royal Navy, from the rather sketchy conditions of the previous century, into the effectively organised and disciplined force familiar to us to-day: clearly the two things went together. But although the Admiralty commissioned the surveys it seems to have made little use of the work once it was done. If any charts were issued, they were purely private ventures without any official guarantee: the surveyor was obliged

to deposit the results of his work with the Admiralty, but he apparently held the copyright and was free to dispose of it to a map publisher for his own profit. This state of affairs lasted until after 1800, though some really good surveying had been done at home by official workers like the Murdoch Mackenzies, uncle and nephew, and especially by their younger relative, Graeme Spence, who is an important figure in navigational history.

THE HYDROGRAPHIC DEPARTMENT IS FOUNDED

Meanwhile an undigested mass of material was accumulating in the Admiralty and the Navy was getting impatient for reliable charts. It is said that at the battle of Quiberon Bay (1759) none of the available charts bore the slightest resemblance to another—and still less to the actual facts. At long last the agitations bore fruit in the form of an *Order in Council* dated 12th August, 1795, by which the post of Hydrographer to the Board was created: and this was really the birth of the Hydrographic Department. An extract from the *Order* will give some idea of the duties of this new official

> 'to take charge of such plans and charts as are now or may hereafter be deposited in this office belonging to the Public, and to be charged with the duty of selecting and compiling all such information as may appear to be requisite for the purpose of improving the Navigation, and for the guidance and direction of the Commanders of Your Majesty's Ships'

Nothing about surveying: but otherwise a pretty wide commission if taken in all its implications. However, there was the usual sting in the tail of the *Order*, for it stipulated that this post should not involve an extra expenditure of more than £470 a year, out of which the Hydrographer was to pay, not only himself, but any staff that he might want to employ: it does not look as though the *Order* contemplated anything very spectacular in the new office.

THE FIRST HYDROGRAPHER

There was no difficulty in finding a man for the post: the choice was Alexander Dalrymple, F.R.S., who was then in his fifty-ninth year and held the post of Hydrographer to the East India Company, which he was allowed to retain. Dalrymple had, in fact, been offered the post of Hydrographer to the Navy in 1770 at a salary of £500 a year and had provisionally accepted it, but for some reason the scheme was then abandoned by the authorities. He was a distinguished geographer and had a long record of marine surveying in the East: moreover, he had published twenty-five years before a thoroughly practical text book on the subject which was probably the first of its kind in the country. The first Hydrographer was a man of great energy and concentration: less happily, he was of the type that is called, according to your fancy, either determined and tenacious, or aggressive and pig-headed. He certainly knew his own mind and stuck to his decisions. With a tiny staff, he managed to reduce the chaos of material to order, to draw and engrave new charts, and to buy in other plates from private publishers. But he had a theory—or, to be generous, an ideal: he would not issue anything until certain standards that he had set, of accuracy and completeness, were fulfilled. That was all very well, but the Napoleonic war was at its height and the Navy wanted charts, not theories—and those quickly. The rumblings of complaint grew to a storm that burst in 1808, when the report of a committee of enquiry led to a firm insistence on his retirement:

A 'Saltzman' Vertical Projector: precise enlargements and reductions are made rapidly with these instruments which work on the epidiascope principle

he died shortly afterwards—of mortification, it is said. His post was immediately taken by Captain Thomas Hurd, R.N., one of the three naval officers who had tried and condemned him.

CHARTS COME TO THE MERCHANT SEAMAN

In the next fifteen years the young ' Hydrographical office ' grew up, if not to maturity, at least to an easily recognisable junior of its later form. It had troubles, of course : it was nobody's baby and jealous eyes grudged every penny spent on it. It was not yet an Admiralty Department in its own right : its control by the Board was vague and passed from one hand to another, but settled more definitely in that of the First Secretary, John Wilson Croker, whose contemporary eminence in learned society did not extend to any benevolence towards hydrography. Yet Captain Hurd managed to get a good deal done : in two years or so after his appointment, he was able to issue regular supplies of charts to each station and, most important of all, he secured the selection and appointment of surveying officers and of their work directly in the Hydrographer's hands. Towards the end of his life he made Admiralty charts publicly available by extracting them from the jealous privacy of Naval use, and so earned the gratitude of the merchant marine of succeeding ages.

THE BEGINNING OF ADMIRALTY CARTOGRAPHY

Meanwhile the technique of surveying was progressing and its fields of activity were co-ordinated under the Hydrographer's direction. Moreover, the bad old practice of private publication had at last been superseded by the official issue of charts from surveys. Unlike Dalrymple, Captain Hurd was not trammelled by scientific associations : he seems to have confined his attention to the naval and surveying sides and to have left the office and chart producing organisation largely in the capable hands of his Assistant Hydrographer, Mr. John Walker. Walker had been Dalrymple's ' lucky find ' : he came from a well known map-engraving family and, in the days when cartography (such as it was) remained something of a trade ' mistery ', he brought invaluable technical knowledge to the department. It was due to Walker's foresight in buying up many chart plates that were being sold as scrap copper that the regular issue of charts began as soon as it did. In many other ways, Walker proved himself the mainstay of the shore aspect of the growing department up to the year of his death (1831) : two of his sons continued to work in the office for thirty-five years after their father's death and the elder, Michael, inherited all his father's great ability. Another son, John, was a distinguished figure for nearly fifty years in the Survey of India : British cartography, of both sea and land, owes a heavy debt to this family.

EXPLORERS AND SURVEYORS

We must go back for a moment to see what had been happening to survey work since the last days of the eighteenth century. Captain Hurd himself had been responsible for one of the landmarks in development with his great survey of Bermuda, which took the nine years from 1791 to 1799 to execute and which set a new standard of precision and thoroughness. At this period marine surveying, if not chart production, was very much to the fore, and many officers, of distinctly varying qualifications, were making surveys of places they visited.

A Chart Branch Conference : a weekly meeting of the senior members of the Branch considers the action that should be taken on newly received material

A cartographer at work : an electrically operated calculating machine assists him in a prolonged computation

This had one great advantage : many voyages that might have been mere voyages of discovery enhanced their utility by producing much sound survey information of the places they explored. An outstanding example of this was Vancouver's voyage along the north-west coast of America. Captain Matthew Flinders, too, had greatly enriched our hydrographic knowledge of the north and east coasts of Australia and might have done a great deal more if he had not had the bad luck to be captured by the French, in whose hands he spent nearly seven years captivity in Mauritius. When Flinders got back to England in 1811, there was not a single surveyor employed officially at home or abroad : it was at this juncture that Captain Hurd was able to appoint George Thomas, Master, to continue the work of Graeme Spence, and so to establish the Hydrographer's direct control of surveyors and their work.

THE SURVEYING SHIP APPEARS

In 1814 (the year of Flinders' death) surveying ships appeared for the first time in the Navy List and soon after we meet the names of such pioneers of the department's surveyors as Beaufort, Bayfield, W. F. Owen, Smyth, de Mayne and Vidal. That systematic and accurate surveying of the waters of nearly all the world that was to be the great glory of nineteenth century British hydrography had been well and truly begun.

AN HISTORIC SURVEY

About the end of April, 1823, Captain Hurd passed away, literally, if the legend be true that he walked out one evening from the house in which he was staying and was never seen again. For some reason—perhaps because Mr. Croker was then busy founding the Athenaeum Club—no appointment was made for seven months and the direction of the whole department fell upon John Walker. The official atmosphere at this period was more than usually unfavourable and the situation must have been very difficult. Some important survey work was in progress, however, of which the outstanding example was Captain (afterwards Vice-Admiral) W. F. Owen's great survey of 30,000 miles of the African coasts. In five years of self-sacrificing effort the work was achieved, in the face of every sort of difficulty, not only of climate, disease and native hostility, but also of official obstruction, for Owen remarks in his own narrative, ' No office ever defeated the intention of its projectors so perfectly as the Navy Board.' A great authority has said of his work that,

> ' this gigantic survey, embracing the east and west coasts of Africa, from the Isthmus of Suez round by the Cape of Good Hope to the Pillars of Hercules, may be said to have been drawn and coloured with drops of blood.'

THE DEPARTMENT IN DIFFICULTIES

When at long last an appointment was made at the end of November, it was not one of the mature surveying officers who was chosen but the dashing and gallant young William Edward Parry, post captain at the age of thirty-one and back only a few days before from his second arctic voyage. Almost at once this new Hydrographer began planning a fresh expedition, this time to achieve the North Pole. By the following May he was out of England and did not return for a year and a half : and all this at a time when a strong and influential leader was most urgently needed to withstand the attacks of the opposition on the

A draughtsman using flexible splines for drawing curves on charts designed for use with Radar

The Curator in the Original Document Repository : the Department's archives include over 300,000 surveys, charts and maps, some of which are of great historical interest

Board. John Walker continued in charge and, despite the increasingly discouraging atmosphere, he managed to keep the machine running and even to prepare, at the suggestion of Sir George Cockburn, a scheme for a new survey of the English coast based on the Ordnance Survey triangulation—a scheme that was afterwards put to good use. The fact was that for a few years a wave of post-war economy, of the type to become so sadly familiar a century later, had been repressing Naval expenditure and this reached its climax, even after Parry's return, when a number of surveyors, including such men as Peter Heywood and Owen, who were preparing their surveys for chart production in the office, were summarily dismissed and the publication of the charts cancelled. It is recorded that the results of much good survey work were lost to the department for ever as the price of Mr. Croker's penny-saving.

AN ARCTIC FAILURE

Two events of this time mark stages in the department's work, for in 1825 the first *Catalogue of Admiralty Charts* appeared: and soon after came the first volumes of *Sailing Directions*, a matter in which Parry had shown some personal interest. The lure of the North was too strong, however, and after sixteen months in the office, Parry was off for his fourth arctic expedition. During his absence a gleam of sunshine fell on the department with the personal interest of the Duke of Clarence as Lord High Admiral: the dismissed surveyors came back, charts were ordered for production and other reforms made. We may see the hand of John Walker in the acquisition of six draughtsmen, under the Duke's order, to make some headway with the arrears. Meanwhile the Hydrographer was encountering some difficulties in achieving a new 'farthest north': the discovery that the ice on which he was travelling northward in sledges was moving southward at about the same rate was discouraging and after some six months of disappointment he returned to his post at the end of 1827. However, he soon found that progress in the Hydrographic Department, after the Duke of Clarence had resigned and with Mr. Croker in control again, was even slower than that in his northbound sledges and early in 1829 he threw up the post as hopeless. Of the six years since Hurd's death, Parry had spent a total of under three and a half in the office, broken into three periods: it was not in such hands that obstruction was to be overcome and firm advance achieved.

TRADE, THE HIDDEN DICTATOR OF SURVEYING

It must be confessed that neither the advent of the great Hydrographer, Francis Beaufort, nor the departure of the arch-enemy Croker was the real cause of the achievements of the half century following 1829. The inexorable pressure of economic expansion would have forced some such results from any authorities. British trade, foremost in the industrial revolution, was pouring out its goods in an increasing flood: the overseas markets had to be secured before late starters came into the field. Passages to existing markets had to be made safe and routes opened up to navigation in fresh areas of trade: and all this, not only for an outward trade, but also for the collection of those imports by which payment for exports must be made. The Surveyor and the Merchant went hand in hand while British commercial prosperity was leaping to its peak all unconscious of, or blind to, the consequences that it was piling up for the unfortunate grandchildren of that generation.

Plate 1. A nineteenth century surveying vessel: H.M.S. Hecate, paddle sloop, arriving at Honolulu on her return voyage to England, after nearly four years' service (1859-1862) on the survey of British Columbia, under the command of Captain George Richards, R.N. (afterwards Hydrographer of the Navy). A sister ship, H.M.S. Hydra, was also extensively used for survey work
(From a contemporary painting)

Plate 2. Polruan Pool, entrance to Fowey Harbour.
Portion of Admiralty Chart No. 31, "Published according to Act of Parliament by Capt. Hurd, R.N., Hydrographer to the Admiralty, 10th March, 1813.
Slightly reduced. See Chart Title, Plate 4

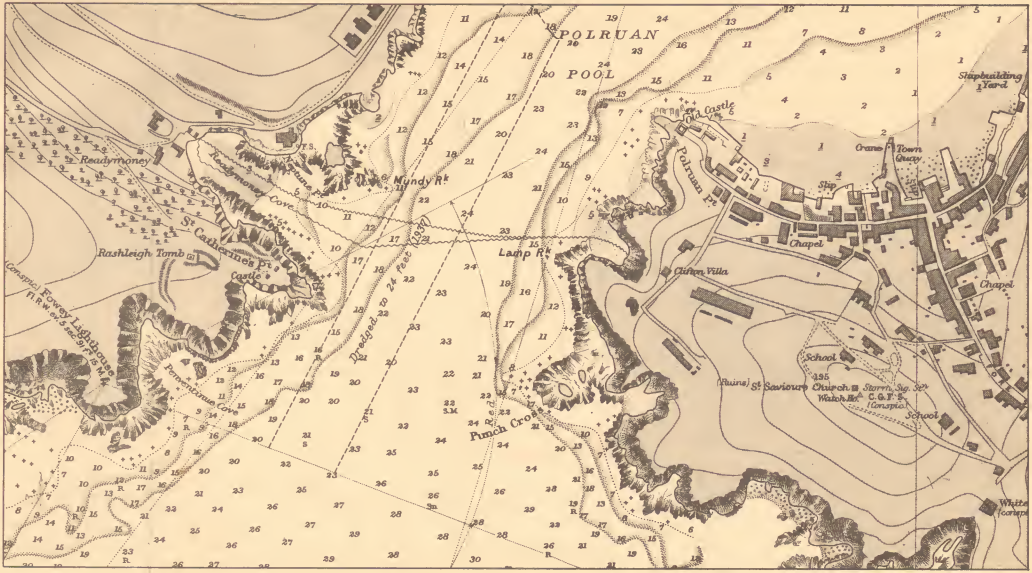


Plate 3. Polruan Pool, entrance to Fowey Harbour.
Portion of Admiralty Chart No. 31, * Published at the Admiralty, 26th Oct., 1928, under the Superintendence of Rear Admiral H. P. Douglas, C.M.G., Hydrographer, with corrections to 1946
Slightly reduced. See Chart Title, Plate 5

To the Mayor and Free Burgesses
of the
BOROUGH of FOWEY,

This Plan of the

HARBOUR OF FOWEY,

Laid down from actual Survey by

Mr. GEORGE THOMAS

In the Year

1811,

Is inscribed with Respect and Gratitude,
by their faithful and obliged
humble Servant,

Reginald Pole Carew.

John Walker Junr. Sculpt.

Scale of half a Nautic Mile

Plate 4. Title of Admiralty Chart No. 31, when first issued in 1813.
Reduced. See Plate 2

Price Three Shillings

ENGLAND SOUTH COAST

FOWEY HARBOUR

Surveyed by Lieut. Comm^r D.A.Henderson R.N. and the officers of H.M. Surveying Ship "Flinders" 1925.

Soundings in the deep water channel from Polruan P^t to Penleath P^t from a survey by Comm^r S.A.G.Hill D.S.O. R.N., H.M.Surveying Ship "Endeavour" 1924.

Partly re-sounded by Comm^r W.V.Rice, D.S.O., D.S.C., R.N., H.M.Surveying Ship "Beaufort" 1926.

The Topography is taken chiefly from the Ordnance Survey.

Polruan C.G.F. S. Lat. 50° 19'.35·5 N., Long. 4°.38'.03·3 W.

Magnetic Variation in 1927, decreasing about 12' annually.

All Bearings are True (thus - 126° etc) and are given from Seaward.

Underlined figures on the banks indicate the heights in feet above the datum of soundings.

All other heights are expressed in feet above High Water Springs.

SOUNDINGS IN FEET

reduced approximately 1·2 feet below the level of Mean Low Water Springs

Natural Scale $\frac{1}{2500}$

NOTE-*For abbreviations see Admiralty Chart 5011.*

Conspicuous Objects

C.G.F.S. Polruan	Whitehouse P^t Lighthouse
Fowey Lighthouse	F.S. Place House
St^t Pimbarrus Ch.	Windmill *(Pilkum)*

Tidal Information

Place	Lunitidal Intervals H.W.F.&C.	Lunitidal Intervals L.W.F.&C.	Height above datum of soundings Mean H.W Springs	Height above datum of soundings Mean H.W Neaps	Height above datum of soundings Mean Tide Level	Datum to which Soundings are reduced
Fowey	Y^h 14^m	Er^h 38^m	14·1 feet	12·1 feet	8 feet	27·6 f^t below the base of the Mercurmo on Victoria Quay, or 8·53 f^t below Ordnance Datum.
Mevagissey	Y^h 04^m	Er^h 22^m	13 "	10·4 "	10·1 "	
East Looe	Y^h 26^m	Er^h 52^m	16·1 "	13·1 "	9·1 "	9 f^t below Ordnance Datum

Scale of Latitude and Distance

0 1 2 3 4 5 Cables or 5 Sea Miles (3·042 St Mi)

Scale of Feet

Feet 1000 500 0 1000 2000 Feet

Scale of Metres

Metres 500 0 500 1000 Metres

Conversion Table

Metres	Feet	
0·305	1	3·28
0·610	2	6·56
0·914	3	9·84
1·219	4	13·12
1·524	5	16·40
1·828	6	19·69
2·134	7	22·97
2·438	8	26·25
2·743	9	29·53
	Metres	Feet

Plate 5. Title of Admiralty Chart No. 31, when re-issued in 1928.
(Note: Tidal Information is no longer expressed in this manner and the Seal has since been re-designed).
Reduced. See Plate 3

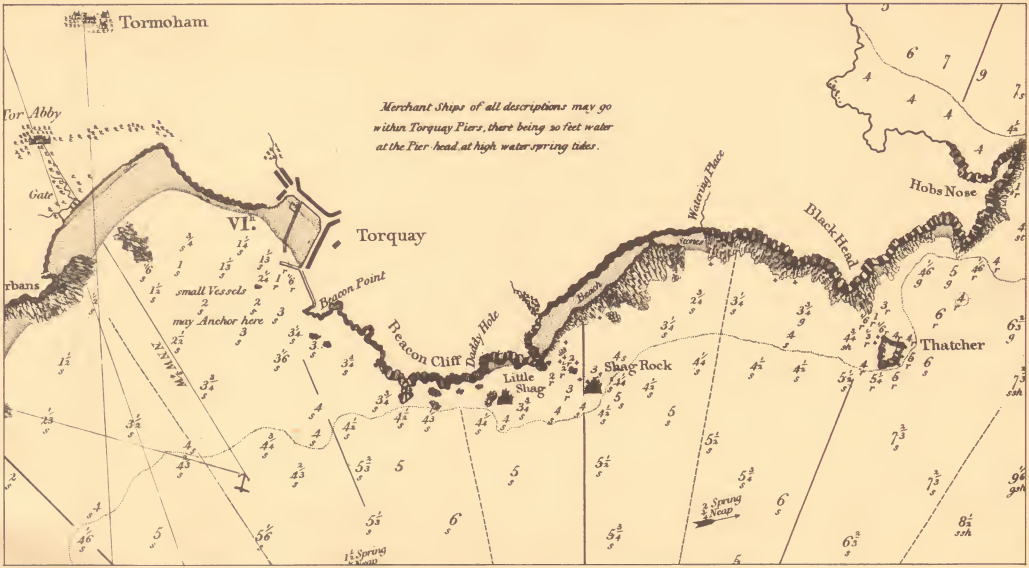


Plate 6. Torquay. Portion of Admiralty Chart No. 26, as first published in 1808. The survey was made by Lieut. Murdoch Mackenzie, R.N., in 1781. Slightly reduced. The soundings are given in fathoms

Plate 7. Torquay. Portion of Admiralty Chart No. 26, from a recent edition. The survey was made by Staff Captain F. Haslewood, R.N. in 1904. Slightly reduced. The soundings are given in feet

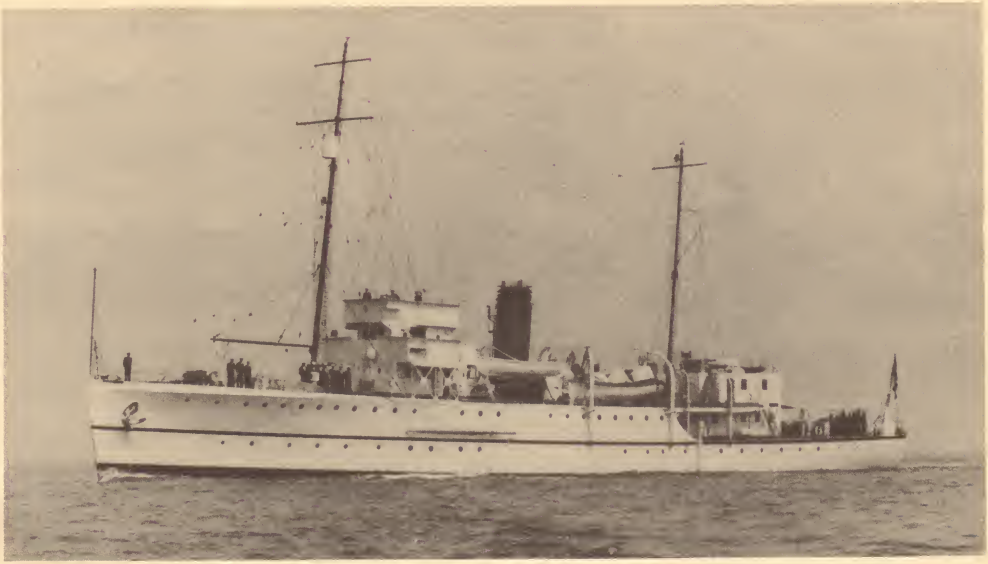
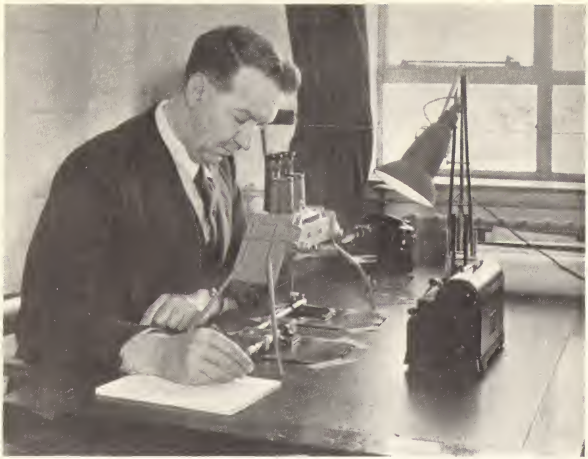


Plate 8. A modern surveying vessel: H.M.S. Scott in Home Waters, 1939



Examination of an Air Photograph : determining heights by means of a stereoscope and parallax bar

THE HIGH-SUMMER OF HYDROGRAPHY

A marine survey does not enjoy finality : much work has to be done over again, often at frequent intervals when the sea bottom is soft and changing, and even over hard and rocky ground when new standards of navigation develop. Hence all through this period our ships were busy not only charting unsurveyed waters but constantly at work in waters of which good charts already existed : and this, of course, is as true to-day as it was in 1830 or 1880. The amount of coast line covered in this half century was prodigious and a mere catalogue of the places would take up several pages : in fact at this time we were surveying everywhere, excepting only the coasts of the two or three Great Powers that had set up their own hydrographic offices. We must suppose—without any great certainty—that there were local arrangements, by which we made ourselves at home in other people's territorial waters : the fact remains that in Europe, Asia, Africa and South America our ships were surveying far and wide. In this high-summer of hydrography a crusading spirit seems to have inspired our naval surveyors. They spent not only themselves, but in many cases their private money as well, to get the most from each season's opportunities. ' No surveying day is too long and no task too arduous ' became their motto : and in their scanty leisure, or in their retirement, they wrote pamphlets, articles and books towards the development of their chosen science. If ever men lived for their work, that can truly be said of the mid-nineteenth century marine surveyors.

HOW THE PIONEERS WORKED

We must try to imagine the conditions under which these men worked to

produce results at which we still marvel, alike for the beauty of their drawings as for the accuracy of their charting: for it has often been found that their surveys in all essentials stand up well when compared with the precise picture obtained with all the aids of mid-twentieth century science. Their vessels were small: the famous *Beagle*, immortalised by Darwin, in which FitzRoy made his great surveying voyage around the east and west coasts of South America, was of only 235 tons burden. Steam was not introduced into the service until after the mid-century and soundings had to be obtained entirely by hand casts with the lead until the first Lucas sounding machine arrived in 1878. They were quite out of touch with higher authority for long periods and had to handle the most unexpected situations with their own resource and courage. One remarkable feature of their work impresses itself on those who still use their surveys in chart work and that is the uncanny sense they seem to have acquired for spotting under-water dangers. The land explorers of this period were made famous and their names have passed into history: the names of these pioneers of marine survey, who made the seas safe for shipping and carried the White Ensign to every corner of the World, are unknown outside the archives of the Hydrographic Department.

ADVENTURES OF A SURVEYOR

Many stories exist of strange happenings during survey work: as examples, here are two incidents in the career of one of the most prolific of these men. Edward Belcher had a picturesque Naval life even as a youth in the Napoleonic wars and was attracted early to surveying. He executed an enormous amount of excellent work in all parts of the world, but especially in the Far East, during some forty years of service. When he was off the Spanish Coast in 1831, his ship got mixed up in the civil war between Don Pedro and Don Miguel and he seemed likely to get cut off from supplies. By his tact and personality he managed to bring officers of both parties to meet at his table and was soon able to arrange an unimpeded use of the markets for our own ships. So highly was he thought of that the opposing leaders had even agreed to meet in his ship to settle the whole affair, when he was ordered back to England and had to abandon this peace-making project. For distinguished services his acting captaincy was made a post-commission in 1841, with a C.B. to go with it and he was knighted two years later, five years before his chief, Beaufort, got his K.C.B. The next year, when surveying off the Philippines, he had to fight a stiff action against pirates: this was successful, but he was wounded in the encounter: this was not his first wound by any means, but it was almost fatal and the skill of the surgeon who saved his life was so exceptional that he was specially honoured for it. Undaunted, Belcher went on to rescue a British crew captured in Borneo and then negotiated two delicate and highly successful diplomatic agreements: these side lines to his work were thought important enough to bring him a shower of applause from all authorities—except one. His own chief, Beaufort, seems to have been infuriated with this success and he wrote Belcher a stinging letter telling him (almost in so many words) to drop all that nonsense and to get on with the work for which he was paid. It is the custom of the Hydrographic Department to name its surveying vessels after famous surveyors of the past: Kellett, Beaufort, Flinders, FitzRoy, Moresby and others have been so commemorated. It is sad to think that, for obvious reasons, it will never be possible to honour Belcher's memory in that way.

THE FATHER OF MODERN HYDROGRAPHY

All this has taken us ' by ways remote and distant waters sped ' a long way from the department at home, which we left in a rather gloomy state on Parry's resignation. For the next twenty-five years Beaufort reigned undisturbed, the longest period of any holder of the office: he found the place almost at the bottom of its fortunes and he left it an efficient, well organised department, a fitting complement of the premier surveying service of the world, that he had done so much to train and develop. Beaufort is truly honoured as the father of all modern hydrography: by experience, scientific reputation and above all, by personality, he was the ideal man to take on the difficult job in 1829 and he left to his successor a vigorous offspring of which the nation might justly be proud. As early as 1831, the ' Hydrographical Office ' became an Admiralty department in its own right and the position of the civil staff was greatly improved—a first step in the gradual change of the journeyman engraver-draughtsman of the days of Dalrymple and Hurd into the university-trained scientific cartographer of to-day.

THE OFFICE ASPECT OF HYDROGRAPHY

We must not forget that besides this work at sea, carried out in a spirit of such high-adventure, there was developing a more pedestrian but no less essential technique, that of translating the survey into a practical chart and of utilising all the associated scientific material to the best advantage of the mariner. It was a longish step from the simple demands of John Walker's day to the accuracy and imagination required in chart preparation at the end of the great period: a still longer step has had to be taken to meet the needs of to-day. Even in 1880 a whole new mathematical technique was growing insistent in its demands for attention. A good survey does not result automatically in a good chart: charts have to be schemed, usually in series, to suit the needs of navigation between the limits of coast shown on each. Surveys have to be reduced to the required scale and a number of them, sometimes of varying age and reliability, pieced together. This means that selection has to be made from the surveyor's ' fair sheet ' and, very often, different triangulations adjusted to fit. Nor is it a question of one chart only: for each new chart produced there will be smaller scales to be corrected for that area, all of which means further reduction, selection and fitting-in. More and more it began to be realised that a navigational chart is not a pictorial map, but a scientific instrument and that it must be treated just like any other instrument that has been carefully made and precisely calibrated. For on the sea, the greater part of the things that are of vital importance to the navigator are hidden beneath the surface and the navigator must be able to place complete reliance on the accuracy of the relative position of the details shown, as well as on the information itself that is contained in these details. Hence rigid and minute accuracy is the first essential of every chart: also, while the mariner must be given everything that is necessary for navigation his eye must not be confused with details that are not of use. Everything must be shown with the utmost clarity and must be entirely unambiguous. The legend that nineteenth century seamen used to swear by their ' faith in God and an Admiralty chart ' is sufficient indication of the way in which the department served their needs.

EXPANSIONS IN THE MID-CENTURY

The activities of the department began to multiply in the mid-nineteenth century and the habit of acquiring new responsibilities seems to have grown with age, for even to-day its work continues to be directed into fresh avenues. In 1842 a Compass Section was added, for the iron ship was superseding the old ' wooden-walls ' and the problem of correcting the compass readings for the disturbance caused by the ship's own magnetism was both complex and acute. The regular issue of that invaluable aid to the seaman, the *Notice to Mariners*, began in 1857. These daily *Notices* tell of important navigational dangers or changes at the earliest moment and it is a vital service that has continued without a break for nearly ninety years : as the chart plates are corrected forthwith and all copies in stock amended by hand, these *Notices* mean a good deal of work in the department. The first Admiralty chart showing curves of constant Magnetic Variation appeared in 1859 : it was of the North Atlantic and fore-shadowed a regular five-yearly issue of such charts covering the whole world. Wind and Current charts soon followed. Pilotage claims and their payment came to the care of the Hydrographer in 1866 and at that date he was responsible for the circulation of more than 1,000 chronometres between the Royal Observatory and H.M. Ships. By that time the sale of Admiralty charts to the public had risen to over 100,000 a year and a somewhat similar number was needed for the ships of the Fleet. In the forty years following Parry's resignation the Hydrographic Department had grown up.

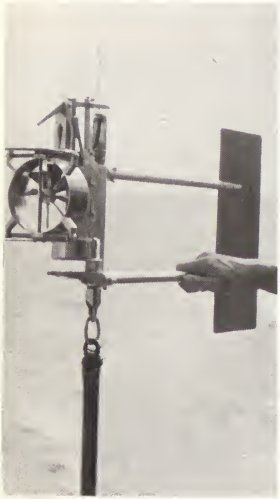
TRIANGLES, CURVED AND FLAT

A great deal of any surveyor's work, either of land or of sea, is concerned with finding how far one place is from another and in what direction the second place lies from the first. On the floor of a room or across a large field this is easy but it is a very different matter over a large distance—a distance that may be a hundred miles or the width of a continent. But when these relative positions are at last determined on the surface of the globe, the cartographer has a further problem in getting a flat piece of paper to represent the curved surface in some satisfactory manner. The surveyor measures by building up a sort of lattice work of triangles which start from some ascertained base line : he measures angles to natural or artificial marks with a theodolite. Sometimes he cannot land on the coast and bas to select a well defined object from offshore. One surveyor in the Red Sea saw a particularly clear white mark on the distant coast and this was ' shot-up ' from several other positions in his chain. At the end of his day, and after wading through all the wearisome calculations, he could get no sense out of the results : this meant a return the next day, but history had not recorded his comments when, on closer inspection, his white mark turned out to be a goat tethered by a long rope. Triangles made out of pieces of a spherical surface behave in a way different from that of those flat triangles of which Plane Trigonometry teaches us : and this is greatly complicated by the fact that the earth is not a perfect sphere. The great precision required as navigational and other uses of charts developed made it imperative that the most delicate refinements should be introduced into all the calculations involved.

CASUALTIES IN WAR AND PEACE

' Other uses ' ? What uses of a chart can there be, you may ask, other than

Using boat's sounding machine to check echo sounding gear



The Ekman Current Meter

Reading the revolution counter of the Ekman Current Meter

for navigation? Actually, chart making has to adapt itself to many other purposes, many of which are still 'on the secret list'; an obvious example is the use with long range naval artillery. If you are going to bombard something on land from fifteen miles away, it will not be much use unless the position of the ship can be fixed accurately on a chart that shows the position of the target with equal accuracy: and modern shooting is of a pin-point accuracy. This brings to mind the remark of a long past Hydrographer that 'a state of war has always proved to be the opportunity of the Hydrographic Department.' He was referring to the Crimean war, in which the authorities were so slow to realise the truth of his statement that they employed Captain Sullivan's surveying vessel in the Baltic as the fleet beef boat! However, hard necessity soon convinced the Command that the surveyor's work was essential to the efficient handling of the Battle Fleet and in due course Sullivan in the Baltic and Spratt in the Black Sea earned praise and promotion for their important and gallant work. Two years later, in 1857, Thornton Bate, one of the best of all surveyors and the most popular of men, was killed placing the scaling ladders for the assault on Canton—where fifteen years before Kellett and Collinson had so distinguished themselves for surveying under fire. But war service was not the only dangerous time for surveyors: Skyring murdered by natives in 1833, Graves stabbed to death at Malta in 1853, Slater killed by falling from a cliff from which he was taking theodolite angles in 1842, are early examples of fatalities on service: the toll of those who have died, often all too young, from tropical fevers and exposure has been a heavy one.

THE INFLUENCE OF WAR ON THE WORK IN PEACE

The remark just quoted was intended, no doubt, to mean that in war-time the Hydrographic Department had the opportunity to prove that its value as an essential part of the naval machine was no less than its value in the peace-time world, and from Napoleonic days onwards this has been amply demonstrated: but there is a quite different meaning in the words. Surveying methods in 1914 did not differ in essentials from those of 1880 or even earlier: greater precision was observed, perhaps, in certain aspects and soundings, taken with improved gear, were closer together, but the text books and Instructions of the 'eighties still held good. After the peace of 1919, most of the methods were revolutionised and these changes came principally from war-time invention: for it cannot be denied, though it may be regretted, that war has a value as a great speeder-up of man's inventiveness and many new ideas that might have found acceptance only after years of endeavour in peace, are put into use overnight under the stress of war. The echo-sounder is infinitely more rapid in obtaining depths than the best machine for taking soundings with a lead. The prismatic astrolabe puts a new certainty on observations for latitude and longitude, especially when the personal factor of the observer is eliminated by means of a mathematical process devised by one of the cartographic staff. Distances at sea, of fifty miles and more, can be measured directly by 'taut-wire'—a thin piano-wire whipped off a drum, with a recording meter, on the ship's deck. The surveyor constructs his 'fair sheets' on a new principle born of war experience. These are but examples of the changes that took place in the inter-war years.

DEVELOPMENTS AT HOME

If the basic elements of surveying had not altered seriously up to 1914 it

Fixing position while ship-sounding

Two officers set off to erect sounding 'marks' along the coast

was not the same in the office on shore where many developments had taken place. The whole department had grown both in numbers and in organisation : the six draughtsmen had become twenty cartographers, thanks to the foresight of Alexander Gibson who had joined in 1874 as a forerunner of the graduate recruits that were to become the standard type of entrant. Young lieutenants came to the surveying branch for early training in a specialist sphere and so formed that fully qualified corps for which Hurd had pleaded nearly a century before. Publications, too, had greatly advanced : from the first slim volume of Lights in home waters only of 1835, the *Admiralty List of Lights, Fog Signals and Visual Time Signals* was growing towards the twelve volume edition of to-day that covers the whole world. *Sailing Directions* were developing towards the seventy-four volumes now published. Tidal work was a whole-time task for an officer and the *Admiralty Tide and Tidal Stream Tables* had changed out of recognition since its first appearance in 1831—though the greatest change in the tidal sphere was to be one of the post-war developments. Printing by lithography had largely superseded copper plate printing for large numbers of a chart, though the engraved copper plate was still the basis of nearly all charts and direct printing from these plates was by no means dead : all this work was still in the hands of a private contractor, while all the sales of Admiralty charts were conducted through a Chart Agent. A Navigation Branch had taken over all the pilotage work that previously devolved on the Hydrographer himself : and a draughtsman grade, to work under the cartographers, had begun entry in 1912. Yet notwithstanding these changes, a certain conservatism overhung the department and could a member of its staff of 1870 have visited it in 1914 he would have found it easily recognisable.

PREPARATIONS

War hits the orderly progress of surveying hard : most of the work has to be abandoned and efforts concentrated on jobs of immediate operational importance. The struggle of 1914-1918 was in the main a land war, but both broad strategy and local actions gave the surveyor and the cartographer plenty of scope to display the utility of his abilities at home and abroad. After the war, the surveyors settled down to make up for lost time (and, alas ! lost personnel) while the shore department began its many expansions. The whole of the work of engraving, reproducing and printing charts came, by stages, into the Department's own hands and this was followed by the direct management of the sale of the charts : a new printing works was erected which, under the stress of the recent war, so developed as to justify a claim to be perhaps the best equipped photo-lithographic establishment in the country. During the inter-war years new techniques of reproduction were explored, which bore full fruit when the testing time came. A Naval Meteorological Branch was added which was destined to play a major part when hostilities broke out again. The science of the physical conditions of the sea—its saltiness, its density, the shape and size of waves, and such like things—had been found useful when the echo-sounder was introduced, but the trend of naval development made it necessary to add an Oceanographic Branch to the department and the paramount importance of this work soon began to be proved when war came. Special charts for the use of naval aircraft had to be produced to cover the world. With its increased staff and acquisition of young recruits with high qualifications and imaginative outlook, the Department seemed well set to cope with the demands of World War No. II.

A typical ' mark ' used for boat and ship-sounding

MEETING THE DEMANDS OF TOTAL WAR

The world war that began on that fateful September 3rd, 1939, proved to be, beyond the wildest dreams of romancers, a war of science and technical invention. The experience of the last war and the best forecasts for this, alike proved poor guides to the actual event : the Hydrographic Department, though as well prepared as possible, was no exception to the universal rule that obliged all defence bodies to improvise methods and to adapt themselves rapidly to novel demands. Entirely new devices were produced, which are mostly still in the ' hush-hush ' state ; these had one property in common in the heavy demand they made on the mathematical and drawing capacities of an already overburdened staff. The unprecedented expansion of amphibious operations, especially landings on hostile shores, called for all the surveyors' skill and resource when precise observations had to be made in conditions of great hazard of active and static defence : these operations also required a new type of chart in which the use of many colours was a feature. The great advances in radio led to urgent need for the invention of diagrams of a highly technical nature. The enemy's submarine warfare stirred the department to one of its most humanitarian efforts : a simple form of chart was produced for each ocean showing amongst other things prevailing winds and currents, with elementary instructions on the back about navigation, handling a boat, judging weather prospects and so forth. Each chart was printed in clear colours on waterproof paper and placed in an oilskin wrapper, with paper, pencils, rubber and some simple instruments. These ' boat-charts ' sets were distributed in tens of thousands for the ships' life-boats of the merchant navy and many a boat adrift for days, often without a trained navigator, had good reason to bless the Hydrographic Department for its foresight.

MILLIONS OF MAPS

Very few people have any idea of the map and chart consumption that modern warfare entails as this work does not receive much of the limelight of publicity. For once it is a simple truth, and no wild exaggeration, to say that astronomical figures alone could denote the total number of maps, charts and associated diagrams used by the three Services in the last six years. Even for one isolated operation the total may be in seven figures. It is obvious that for success the maps and charts of the Navy, the Army and the Air Force must agree in every detail: and further all these must also agree with corresponding maps and charts produced by our Allies. This is not only a matter of details shown, but also of the precise agreement of a highly sensitive overprinting of rectangles by which exact positions can be stated quickly: this is the most harassing task for the cartographer working against time, for disagreement between maps and charts of Allies may lead to disaster, and disagreement is so easy when data are conflicting and there is no time for conference and mutual decision.

"IT'S ALL IN THE DAY'S WORK"

Suppose an operation is planned: months ahead the location and probable chart requirements are notified under 'TOP SECRET' cover. The staff begins work at breakneck speed to prepare the special sheets needed: and these often mean separate drawings for each of some six or seven colours. No one knows the date of the operation—that is the last secret to be divulged, so things must be prepared for the earliest moment. Every conceivable source of information is ransacked and special air photographs are supplied by the R.A.F. After nights and days of work, all is ready for reproduction, and a similar rush goes on in the printing works. At last corrected proofs are ready—and there perhaps they sit for months while the staff is switched to prepare for alternative plans and other operations. But they are not forgotten: sooner or later comes the 'date for delivery' and for security reasons notice of this is always short—D-day will be close at hand. Then comes the last minute rush of corrections: perhaps our surveyors have had time to creep out again amongst the mines and obstructions, perhaps an enemy document has been captured that helps and there is certain to have been a spate of fresh air photography—all this has to be incorporated at the last moment. Somehow it all gets done and then it is the turn of the printers: day and night the great rotary presses pour off their copies which are checked, folded, collected in the right arrangement of sets and then baled and addressed. Now comes one of the most exasperating tasks: the Issues officer has a list of all ships and parties that are to receive these packages, but ships and naval parties are highly secret bodies and are far from stationary, and he has to locate each one and arrange or improvise transport in last minute conditions of urgency. Never once has an operational requirement been behind schedule time in production and no one has been missed in despatch. Some idea of the numbers involved in these eleventh hour rushes can be given by the figures for the great D-day in June, 1944: the naval requirements alone of the British sector demanded the printing of just on a million charts and the safe despatch to over 6,000 scattered units of some 30,000 bales.

THE DEPARTMENT'S OFFSPRING IN THE EASTERN THEATRE

The end of the war in Europe brought little respite to the department:

every special job done during the war meant that some of the ordinary, but none the less essential, work had to be put aside, and the arrears of chart correction and production that must be overtaken before navigational charts are up to standard again need all the energies of the staff. Only long-term commitments for the Far Eastern war could be undertaken at home, though charting of that theatre received special attention: the speed of war to-day demands that immediate requirements shall be met on the spot. So naval and civilian staff went East and miniature Hydrographic Offices were set up in the Eastern theatres of war: but even these were not sufficiently near, and so a surveying vessel was fitted up as a floating Hydrographic Department, carrying on board in addition to all the usual surveying personnel, a cartographic office and a photo-lithographic printing works.

A STRENUOUS FUTURE FOR HYDROGRAPHY

Now the war is over and soon the last of its maritime evils of mined areas, destroyed harbours and blocked channels will be cleared up. The war has produced many new methods that may change surveying technique once again in a drastic manner: nor will these be without a marked effect on navigation. The Hydrographic Department will have many new fields to plough as well as its many old fields in which so much is required to restore full capacity of service to the mariner. In peace or war there is no rest for the Hydrographer of the Navy and his ships and his staff: for there can be no end to the work of the Department whose honour it is to serve all those 'that do business in great waters.'

A LIST OF HYDROGRAPHERS OF THE NAVY

1795–1945

(Several of the officers in this list attained higher rank and honours after retirement from the position of Hydrographer)

1795–1808	Alexander Dalrymple, Esq., F.R.S.
1808–1823	Captain Thomas Hurd, R.N.
1823–1829	Captain Sir William Edward Parry, R.N., F.R.S.
1829–1855	Rear-Admiral Sir Francis Beaufort, K.C.B., F.R.S.
1855–1863	Rear-Admiral John Washington, F.R.S.
1863–1874	Rear-Admiral George Henry Richards, C.B., F.R.S.
1874–1884	Captain Sir Frederick John Owen Evans, K.C.B., R.N., F.R.S.
1884–1904	Rear-Admiral Sir William James Lloyd Wharton, K.C.B., F.R.S.
1904–1909	Rear-Admiral Arthur Mostyn Field, F.R.S.
1909–1914	Rear-Admiral Herbert Edward Purey-Cust, C.B.
1914–1919	Rear-Admiral Sir John Franklin Parry, K.C.B.
1919–1924	Vice-Admiral Frederick Charles Learmonth, C.B., C.B.E.
1924–1932	Vice-Admiral Henry Percy Douglas, C.M.G.
1932–1945	Vice-Admiral Sir John Augustine Edgell, K.B.E., C.B., F.R.S.
1945–	Rear-Admiral Arthur Guy Norris Wyatt.

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